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Foreword

The purpose of the *CDC Surveillance Summaries* is to make available the most current information on conditions of public health interest for which CDC has major responsibility. The reports in this publication complement data provided in the *Morbidity and Mortality Weekly Report (MMWR)* and other CDC publications.

For information on the history of CDC surveillance activities, data sources, and surveillance systems, including the dates of the most recently published reports, refer to *CDC Surveillance Summaries* 1988;37(SS-2), dated June 1988.



RABIES SURVEILLANCE, UNITED STATES, 1987

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Through 1959, rabies surveillance was conducted by the U. S. Department of Agriculture, which primarily monitored the number of cases in domestic animals. The Centers for Disease Control (CDC) assumed responsibility for such activities in 1960.

This report summarizes information sent to CDC from state and territorial health departments, and without the help of persons in these organizations, the report would not be possible. The information in this report is primarily intended for use by persons responsible for rabies control. Any decisions on the treatment of humans or animals exposed to rabies should be made together with those state and local health officials who have the most current surveillance information.

INTRODUCTION

In the second half of this century, the number of reported cases of rabies in domestic animals, especially dogs, dropped markedly, largely because of the urban canine vaccination campaigns that began in the 1940s. The control of canine rabies also resulted in the virtual elimination of indigenously acquired human rabies in the United States; since 1980, only six such cases have been reported.

As the number of cases in domestic animals fell, the number of wild animals reported rabid began to increase, surpassing the number of domestic animals reported rabid for the first time in 1960. Wild animal cases have exceeded domestic cases each year since 1960 (Figure 1). In the 1970s there was a large increase in the number of rabid skunks in the Midwest, and in the late 1970s, surveillance detected the emergence and spread of a rabies epizootic in raccoons in Virginia and West Virginia (1).

In this report, we discuss recent trends in rabies in the United States, emphasizing the species, geographic areas, and secular trends in the epizootics and their relation to public health. All data presented in this report are derived from the number of animals found positive for rabies at state health departments. It is likely that some of the trends noted are influenced by variations in the number and type of animals submitted for testing. Such variation is especially likely to be due to different reasons for submitting animals to state health departments for testing. For example, animals may be submitted if they have bitten a human or another animal, for routine surveillance in a particular area, or because of special interest of a member of the general public or a health department. All these factors may be influenced by seasonal variations in the amount of contact between humans and animals, especially in some parts of the country. In addition, the criteria that state health departments use to accept these animals for testing vary greatly.

METHODS

Specimens from suspected rabid animals are submitted for examination to state public health laboratories by veterinarians and other public health personnel. Laboratory diagnosis is usually based on direct fluorescent antibody tests of brain tissue (2); occasionally, the diagnosis is made by virus isolation in mice or neuroblastoma cells. Each state health department collates its data and submits to CDC a monthly summary of the number of rabid animals by county and species. In some cases, infected brain tissue is submitted to CDC for analysis with monoclonal antibodies as previously described (3).

RESULTS

Rabies in the United States and Its Territories

The United States and its territories reported 4,729 cases of rabies to CDC in 1987 (Table 1, Figures 1-5). There were 4,169 cases in wild animals, 559 cases in domestic animals, and one case in a human (Figure 5). Although rabies cases in bats were distributed throughout the continental United States, almost all cases in terrestrial animals were associated with five distinct viral variants circulating in geographically separate areas. Five major and four minor enzootic areas are now recognized on the basis of the predominant rabid animal in the area and by identification of the viral variant within the area (3). The five major enzootic areas and the dominant host animal in each follow:

- 1) A band of north central states stretching from Montana and Wyoming in the northwest to Kentucky and Tennessee in the southeast, where skunks are the dominant species with rabies.
- 2) A number of south central states, including parts of Texas, Oklahoma, northwest Louisiana, most of Arkansas, and southern Missouri, where a second focus of skunk rabies and a different rabies variant are found.
- 3) Northern California, where a third focus of skunk rabies antigenically similar to that in the north central states is found.
- 4) The southeastern states, where there is a focus of raccoon rabies.
- 5) The mid-Atlantic states, where a separate focus of raccoon rabies is seen.

The four minor enzootics include the following (4):

- 1) A focus of rabies in red foxes in northern New York, an extension of a rabies enzootic currently centered in Ontario, Canada.
- 2) A few cases of rabies in arctic and red foxes in Alaska, part of a long-standing enzootic involving these species in the polar regions of several continents.
- 3) A small focus of rabies in gray foxes in Arizona.
- 4) Another small focus of rabies in gray foxes in Texas.

The total number of cases in 1987 decreased by 822 (15%) from the total in 1986. This decrease continues the downward trend in the total number of rabid animals since the recent peak (7,210 cases) reported in 1981 (Figure 1). Fewer cases occurred in each major wild and domestic host except dogs, for which a 79% increase was noted (Table 1, Figures 3 and 4), and cats. Most states experienced a decrease in cases, but some—particularly four north central states (Iowa, Kentucky, Minnesota, South Dakota) and one Atlantic state (Virginia)—reported more cases than in 1986.

States reporting over 300 cases were Maryland (450 cases), Texas (432), California (395), Virginia (362), and Pennsylvania (324). New Hampshire and Vermont reported no cases, and Hawaii has always been free of rabies.

During 1987, 122 rabies virus isolates from terrestrial animals and one human in the United States were studied with use of a panel of monoclonal antibodies to determine the probable source of infection. As in previous years (3), most isolates resembled the variant from the dominant terrestrial wild animal in the area where the case occurred. The exceptions were isolates from four animals, three foxes and one skunk; these isolates resembled variants usually found in insectivorous bats.

Wild Animals

Wild animals continued to account for the great majority (88%) of reported cases (Figure 5), although there was a 17% decrease in wild animals cases compared with cases in 1986 (Table 1). Compared with 1986 figures, a decrease of similar proportion occurred in each of the three major wild animal hosts: skunks (2,033 cases in 1987, a 15% decrease), raccoons (1,311 cases, a 17% decrease), and bats (629 cases, a 20% decrease) (Table 1).

Skunk rabies

Skunk rabies remains enzootic in most of the midwestern states (Figure 6). Although the number of skunk cases decreased substantially in 1987, the decrease was not uniform in all states where skunk rabies is endemic. In most northern states with enzootic skunk rabies, the peak number occurred in 1981 and, for the most part, the numbers fell steadily through 1984 or 1985. In many of these states, the number of rabid skunks then began to increase again, and in Kentucky and in three adjacent north central states — Iowa, Minnesota, and South Dakota, the increase continued in 1987.

Raccoon rabies

Of the 1,311 cases of raccoon rabies reported in 1987, 1,298 (99%) were reported from the two foci where raccoon rabies is epizootic (Figure 7). The District of Columbia and the mid-Atlantic states of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia reported 965 cases (74%), and the southeastern states of Alabama, Florida, Georgia, and South Carolina reported 333 (25%).

Movement of the epizootic within the mid-Atlantic region is presented in Figure 8, which shows the difference between the number of cases in each county affected by this epizootic in 1987 compared with 1986. In 1987, the epizootic moved into Delaware, eastern Pennsylvania, and southern Virginia. In Delaware, eight rabid raccoons were reported from the area north of the Chesapeake-Delaware canal. The southern portion of the Delmarva peninsula, the peninsula between Chesapeake Bay and the Atlantic Ocean that contains parts of Delaware, Maryland, and Virginia, remained rabies-free. There was a decrease in cases in southern Pennsylvania and adjacent parts of northern Maryland. Overall, Pennsylvania and Maryland reported substantial decreases in the number of rabid raccoons, while the number reported in Virginia increased 82%, from 139 to 253.

The number of rabid raccoons decreased in the southeastern states. The 333 cases reported for the area represented an 11% decrease from the number in 1986; the entire decrease was due to a 45% decrease in the cases reported by Florida.

Bat rabies

The number of bats reported rabid decreased 20%, from 788 in 1986 to 629 in 1987. As in previous years, bat rabies was widely distributed (Figure 9), with cases reported from all but five states. The largest number of cases (116) was reported from California. Texas reported the second largest number (66), although this represented a 50% decrease from 1986.

Other wild animals

Foxes accounted for slightly less than 3% of the total cases. Of the 119 cases, 53 (45%) were reported from states involved in the mid-Atlantic raccoon epizootic (Figure 10). Seven rabid foxes (not shown in Figure 10) were reported from the North Slope area of Alaska.

Three rabid gray foxes (*Urocyon cinereoargenteus*) were reported within 1 week of each other in Patterson, a small city in Putnam County in southeastern New York; the foxes had attacked several inhabitants and their domestic animals. Because this area is well removed from the area in upstate New York with enzootic red fox rabies, all three rabies virus isolates were analyzed. Monoclonal antibody tests identified rabies variants that are usually found in red bats (*Lasiurus borealis*). A similar cluster in southeastern New York State in 1984 was also attributed to insectivorous bats.

The number of rabid mongooses, found only in Puerto Rico, increased 31% in 1987 to 55. Twenty-two other wild animals reported rabid included 10 groundhogs (five in Pennsylvania), two beavers, two civet cats, two bobcats, two pet ferrets, one deer, one armadillo, one coyote, and one timber wolf (Table 1). Of these 22, 14 were reported from mid-Atlantic states involved in the outbreak of raccoon rabies, seven from central states with enzootic skunk rabies, and one from Arizona.

Domestic Animals

Domestic animals continued to account for a small minority (12%) of the rabid animals in the United States (Figure 5). However, in contrast to the decrease in reported wild animal rabies in 1987, the number of reported cases in domestic animals increased 8%, from 516 to 559 cases (Figure 1).

Dog rabies

The overall increase in domestic animal rabies was caused by a 79% increase in cases in dogs, from 95 in 1986 to 170 in 1987 (Figure 4). Five states—Iowa, Kentucky, Minnesota, South Dakota, and Texas—reported more than 10 rabid dogs each (Figure 11). Together, these states accounted for 105 (62%) of the cases in dogs and most of the increase. With the exception of Texas, these states also reported considerably more rabid skunks. The increase from 14 to 29 in canine rabies cases in Texas was largely attributable to an outbreak of canine rabies in a town on the Mexican border.

Other domestic animals

A slight decrease was seen in the number of cases in cattle, one of the other principal domestic hosts; however, as with cases in dogs, some states had notable increases, especially states where a marked increase in skunk rabies was also observed.

The number of rabid cats did not change from 1986 to 1987. In 1987, as in 1986, Iowa reported the most rabid cats (28, a 33% increase) (Figure 12) and rabid cattle (37 cases, a 20% decrease) (Figure 13).

Seasonality

Several temporal trends are apparent when the cases among different species are examined by month (Figure 14). Skunk rabies shows a distinct peak in March and April, with 271 cases reported in March and 312 in April, substantially more than the monthly average of 145 for the rest of the year. Two less distinct peaks occurred in the raccoon cases, one in March (149 cases) and one in September (123 cases). Cases in bats increased steadily from January through August and decreased thereafter.

The peak in cattle rabies followed that of skunk rabies. Canine rabies peaked in April, bovine cases in May, and feline rabies in June and July.

Human Rabies

In December 1987, the first case of human rabies in the United States since May 1985 was diagnosed in a 13-year-old Filipino male from San Francisco (5). The patient had no history of exposure to a rabid animal, lived in a city believed free of terrestrial rabies, and had not traveled outside the United States since emigrating from the Philippines in 1981. The patient presented with priapism and abdominal pain. His cerebrospinal fluid was examined twice in the first 13 days of his illness and was normal both times. Not surprisingly, the diagnosis was made after death. Rabies virus was isolated from brain tissue and typed by monoclonal antibody studies (5). The reactivity of this virus isolate with a panel of monoclonal antibodies to the nucleocapsid and surface viral proteins was identical to that of the rabies variant (strain) associated with the skunk rabies enzootic in northern California, but the source of this patient's exposure to rabies remains unknown.

Rabies in Canada and Mexico

Canada reported 2,777 laboratory-confirmed cases of rabies in 1987, a 24.4% decrease from the 3,878 cases reported in 1986. All of the decrease was due to a 38.5% decline, from 3,273 to 2,010, reported from the province of Ontario. The only other province with over 100 reported cases was Saskatchewan, which reported 615 cases, a 39.8% increase. As in previous years, skunks and foxes were the animals most commonly reported rabid, accounting for 41% and 35% of the cases, respectively.

A total of 14,049 cases, almost all in dogs, were reported from Mexico. This figure includes 8,587 cases diagnosed clinically.

DISCUSSION

Animal Rabies

Rabies surveillance in the United States for 1987, combined with geographic analysis of rabies virus variants, shows the importance of the five major regional outbreaks of terrestrial rabies and each region's dominant species. Important developments included a drop in the total number of animals reported rabid, but a distinct increase in canine rabies for the first time since 1980. The decrease in total animal cases resulted from simultaneous overall decreases in the number of cases in three wild animals (skunks, raccoons, and bats) and in cattle. In contrast to most other states, Iowa, Kentucky, Minnesota, and South Dakota reported substantial increases in skunk cases, with an apparent concomitant increase in canine cases.

The rapid rise in the number of cases of wild animal rabies in the late 1970s and early 1980s was primarily attributable to epizootic skunk rabies in the midwestern

United States. After a peak of 6,126 cases in 1981, the gradual decrease nationwide in the overall number of cases between 1982 and 1984 was the result of a substantial decrease in the number of rabid skunks and a smaller increase in the number of rabid raccoons. This nationwide decline persisted despite increases in the number of rabid skunks in 1985 and in rabid raccoons in 1986, and it continued in 1987, when the number of cases in all major wild animal hosts decreased.

From a peak of 1,604 cases in 1983, the number of cases of raccoon rabies in the mid-Atlantic states has declined each year except 1986 (7). However, this decline has not been uniform, but rather, like the skunk enzootic, reflects substantial changes in the geographic distribution of the outbreak. In spite of a decrease in cases in 1987, the geographic area encompassed by the epizootic has continued to expand.

Human Rabies

Fifty cases of human rabies have been diagnosed in the United States, or in U.S. citizens living outside the country, since 1960 (Figure 15). Of the 39 cases diagnosed between 1960 and 1979, five patients (13%) had no reported exposure to animals (6); since 1980, six (55%) of the 11 patients initially had no reported animal exposure (5,7-10), although one of these cases was later attributed to a bat bite that occurred 7 months before the onset of illness (7). Although this is a larger proportion than was noted in the United States in previous decades, cases of rabies with no known exposure have been noted in the United States previously (11) and have long puzzled investigators in other countries (12,13). The large proportion of cases of unknown source reported since 1980 may be due to a decrease in the number of human rabies cases in the United States: as this number has declined, cases with no recognized exposure make up a larger proportion of the total. Outside the United States, the cause of cases with no reported exposure has sometimes subsequently been attributed to bats (12,14) but often remains undetermined (13).

In the case of human rabies that occurred in 1987 and in a previous one (8), the rabies variants found were similar to those of terrestrial animals in the state where the patient lived, suggesting that a bat strain of rabies virus was not responsible. Although the patients' families and friends were interviewed extensively about possible exposures, the patients themselves were not thoroughly questioned about animal exposures. It is possible that the children did not understand the danger of contact with some animals, or did not report superficial exposures. Both cases involved children who had emigrated from areas with endemic rabies, 4 years (8) and 7 years (1987 case) earlier, raising the possibility of an exposure in their countries of origin; however, rabies cases with incubation periods of a year or more are extremely rare (15).

Because human rabies is rare in developed countries, the diagnosis is especially difficult in the absence of an exposure history. The disease should be considered in the differential diagnosis of any person with a rapidly progressive encephalitis, even if there is no history of exposure to an animal.

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TABLE 1. Rabies in the United States, 1987

State	Total	Total Domestic	Total Wild	Dogs	Cats	Cattle	Horse Mules
Species							
Total	4,729 ^a	559	4,169	170	166	174	39
Ala.	81	1	80	-	1	-	-
Alaska	8	1	7	1	-	-	-
Ariz.	84	3	81	-	2	-	1
Ark.	123	8	115	3	1	4	-
Calif.	395 ^b	11	383	4	3	4	-
Colo.	33	-	33	-	-	-	-
Conn.	3	-	3	-	-	-	-
Del.	9	-	9	-	-	-	-
D.C.	45	2	43	1	1	-	-
Fla.	111	9	102	3	5	-	1
Ga.	209	10	199	5	4	-	1
Hawaii	-	-	-	-	-	-	-
Idaho	10	-	10	-	-	-	-
Ill.	46	4	42	2	-	2	-
Ind.	20	1	19	1	-	-	-
Iowa	272	90	182	14	28	37	10
Kans.	42	5	37	3	1	1	-
Ky.	137	32	105	24	1	3	4
La.	13	1	12	-	1	-	-
Maine	3	-	3	-	-	-	-
Md.	450	8	442	4	2	2	-
Mass.	5	-	5	-	-	-	-
Mich.	28	-	28	-	-	-	-
Minn.	255	86	169	25	21	32	6
Miss.	9	-	9	-	-	-	-

Horses/ Mules	Sheep/ Goats	Swine	Skunks	Foxes	Bats	Raccoons	Rodents and Lagomorphs*	Other Wild [†]
39	8	2	2,033	119	629	1,311	12	65
-	-	-	3	1	21	55	-	-
-	-	-	-	7	-	-	-	-
1	-	-	53	5	22	-	-	1 ^f
-	-	-	111	-	2	1	-	1 ^g
-	-	-	262	4	116	1	-	-
-	-	-	3	-	30	-	-	-
-	-	-	-	-	3	-	-	-
-	-	-	-	-	1	8	-	-
-	-	-	-	-	-	42	-	1 ^h
1	-	-	1	8	22	71	-	-
1	-	-	16	4	13	166	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	10	-	-	-
-	-	-	30	-	12	-	-	-
-	-	-	7	-	12	-	-	-
10	1	-	161	4	12	1	-	4 ⁱ
-	-	-	34	-	3	-	-	-
4	-	-	96	6	2	-	1 ^a	-
-	-	-	11	-	1	-	-	-
-	-	-	-	-	3	-	-	-
-	-	-	20	18	18	384	2 ^b	-
-	-	-	-	-	5	-	-	-
-	-	-	4	-	24	-	-	-
6	1	1	163	2	3	-	-	1 ^j
-	-	-	-	-	9	-	-	-

Mo.	59	6	53	1	5	-	-
Mont.	187	21	168	-	3	17	1
Nebr.	17	2	15	1	1	-	-
Nev.	15	-	15	-	-	-	-
N.H.	-	-	-	-	-	-	-
N.J.	18	-	18	-	-	-	-
N.Mex.	3	-	3	-	-	-	-
N.Y.	57	1	56	-	-	1	-
N.C.	8	-	8	-	-	-	-
N.Dak.	129	34	95	6	9	18	1
Ohio	15	-	15	-	-	-	-
Okla.	35	9	26	1	5	3	-
Oreg.	5	-	5	-	-	-	-
Pa.	324	12	312	2	9	1	-
P.R.	70	15	55	9	2	1	2
R.I.	2	-	2	-	-	-	-
S.C.	59	13	46	5	8	-	-
S.D.	228	53	175	13	11	23	3
Tenn.	97	10	87	4	4	2	-
Tex.	432	69	363	29	19	13	6
Utah	7	-	7	-	-	-	-
Vt.	-	-	-	-	-	-	-
Va.	362	20	342	2	12	3	2
Wash.	10	-	10	-	-	-	-
W.Va.	79	2	77	-	2	-	-
Wis.	48	17	31	5	5	6	1
Wyo.	72	3	69	2	-	1	-
Percent [†]	100.0	11.8	88.2	3.6	3.5	3.7	0.8
Total							
1986**	5,551	516	5,035	95	166	197	43
% Chg ^{††}	-14.8	+8.3	-17.2	+78.9	0.0	-11.7	-9.3

*Rodents and lagomorphs include: (a) groundhog; (b) 2 groundhogs; (c) 2 groundhogs; (d) 2 groundhogs; (e) 2 groundhogs; (f) bobcat; (g) coyote; (h) ferret; (i) ferret, 2 civet cats.

†Total includes one human case

‡Percentage of all rabid animals in 1987

**1986 total by species

††Percent change from 1986

-	-	38	-	15	-	-	-
-	-	151	1	14	-	-	-
-	-	14	-	1	-	-	-
-	-	-	-	15	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	18	-	-	-
-	-	-	-	3	-	-	-
-	-	2	6	48	-	-	-
-	-	-	-	8	-	-	-
-	-	93	1	1	-	-	-
-	-	1	1	11	2	-	-
-	-	21	-	4	1	-	-
-	-	-	-	5	-	-	-
-	-	40	10	16	240	5 ^d	1 ^f
-	1	-	-	-	-	-	55 ^k
-	-	-	-	2	-	-	-
-	-	1	-	4	41	-	-
3	-	169	-	3	3	-	-
-	-	79	1	7	-	-	-
2	-	278	15	66	3	-	1 ^l
-	-	-	-	7	-	-	-
-	-	-	-	-	-	-	-
1	-	57	23	6	253	3 ^d	-
-	-	-	-	10	-	-	-
-	-	32	2	4	38	1 ^a	-
-	-	23	-	7	1	-	-
-	-	59	-	10	-	-	-
0.2	0.0	43.0	2.5	13.3	27.7	0.3	1.4
13	2	2,379	207	788	1,576	15	60
-38.5	0.0	-14.5	-42.5	-20.2	-16.8	-20.0	+8.3

gs; (c) 5 groundhogs; (d) 2 beavers, groundhog
 civet cats, deer; (j) timber wolf; (k) 55 mongooses; (l) armadillo

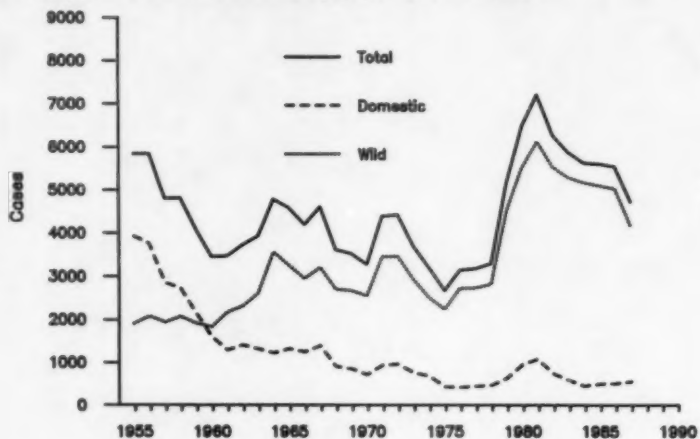
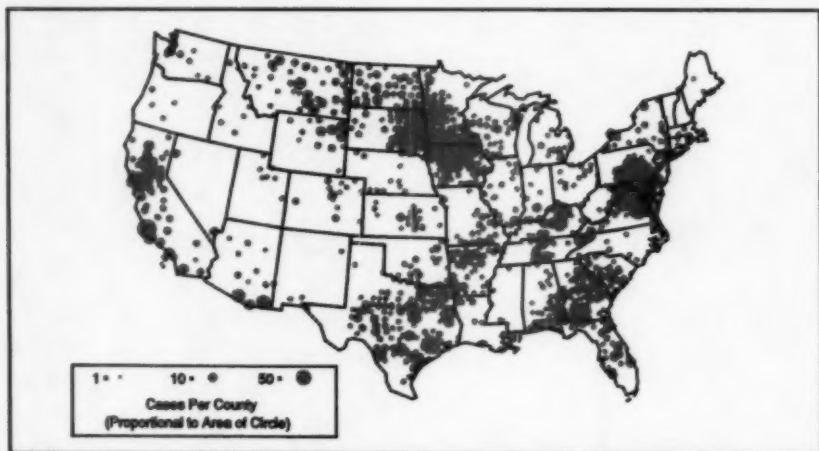
FIGURE 1. Reported rabies in animals by year, U.S., 1955-1987**FIGURE 2. Reported cases of rabies in animals, by county, 1987**

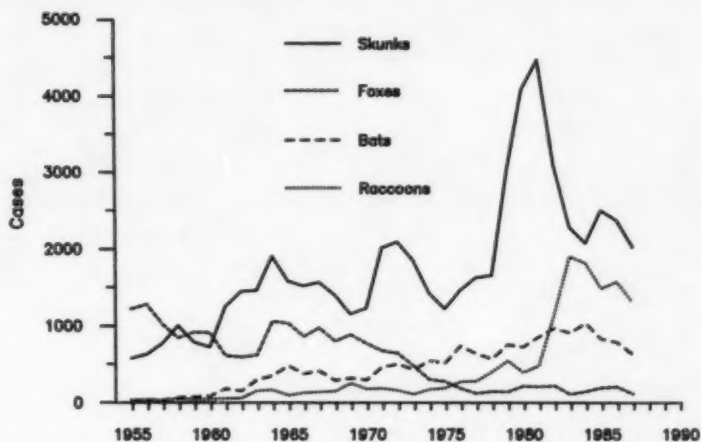
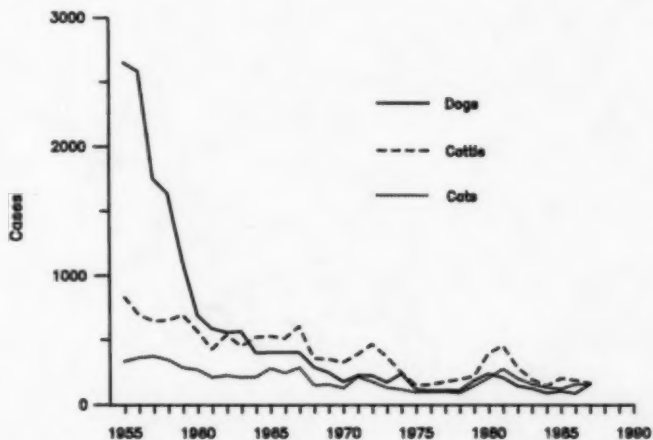
FIGURE 3. Reported cases of rabies in wild animals, by year, United States, 1955-1987**FIGURE 4. Reported cases of rabies in domestic animals, by year, United States, 1955-1987**

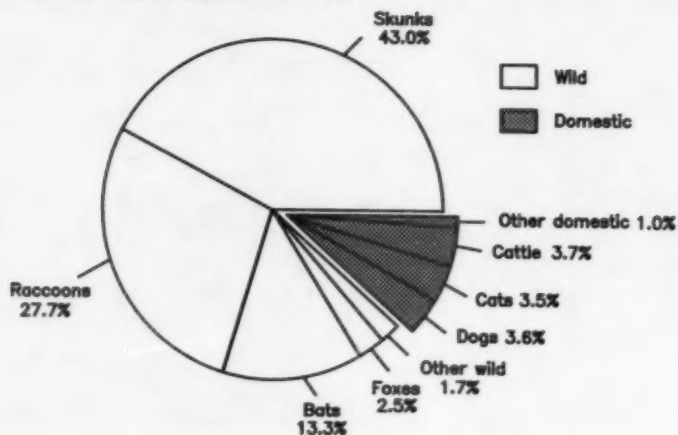
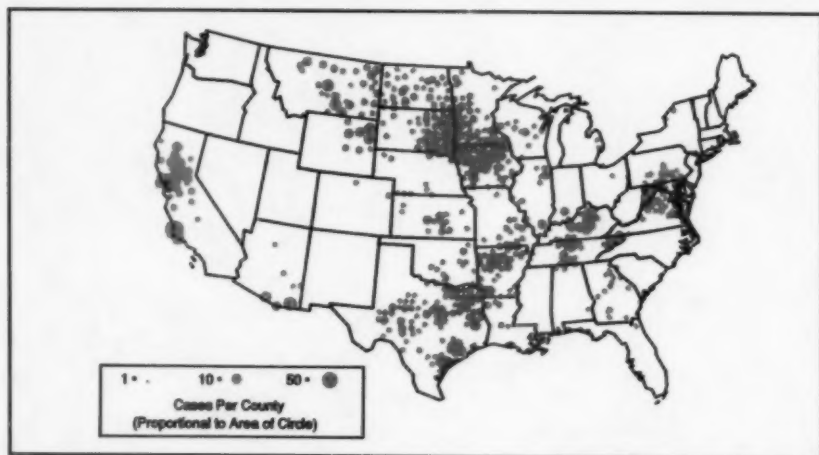
FIGURE 5. Animal rabies, United States, 1987**FIGURE 6. Reported cases of rabies in skunks, by county, 1987**

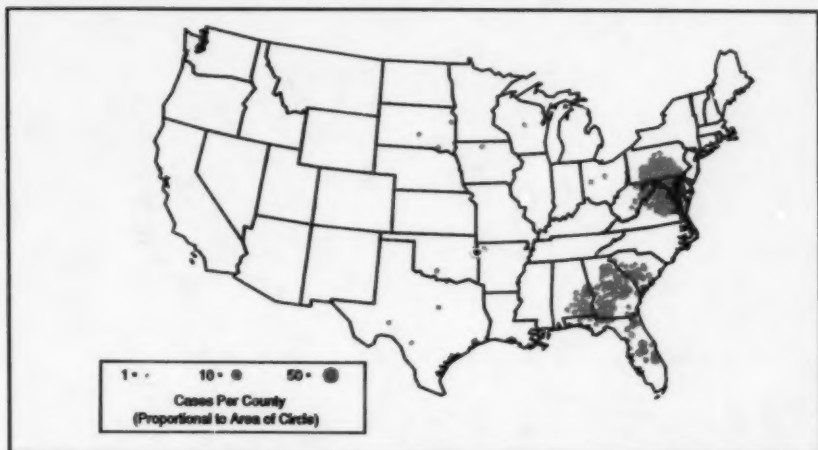
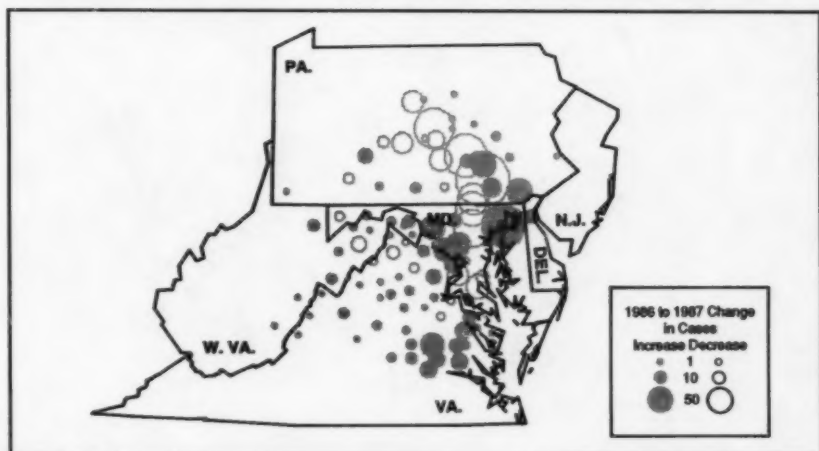
FIGURE 7. Reported cases of rabies in raccoons, by county, 1987**FIGURE 8. Changes in cases of rabies in raccoons, by county, 1986-1987**

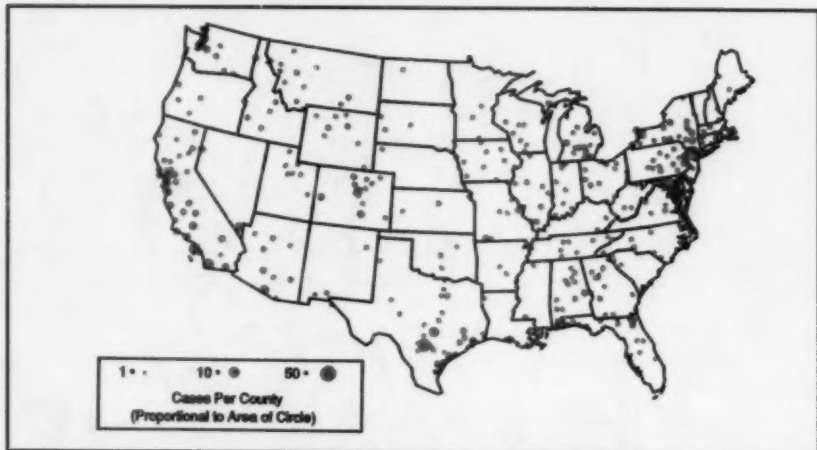
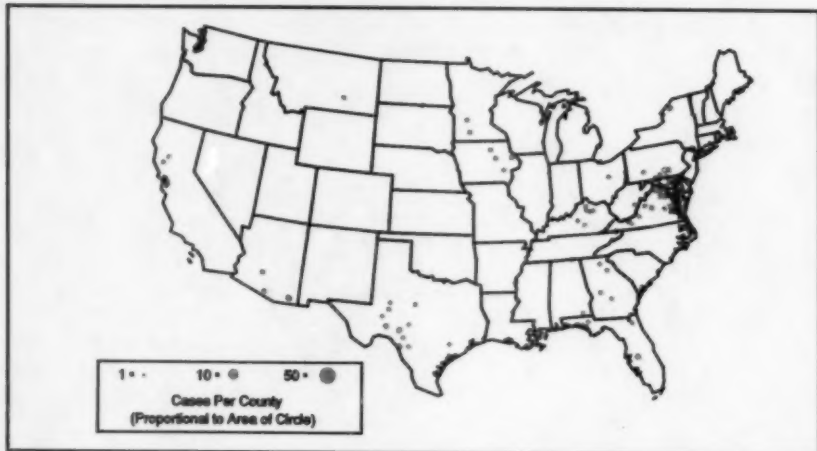
FIGURE 9. Reported cases of rabies in bats, by county, 1987**FIGURE 10. Reported cases of rabies in foxes, by county, 1987**

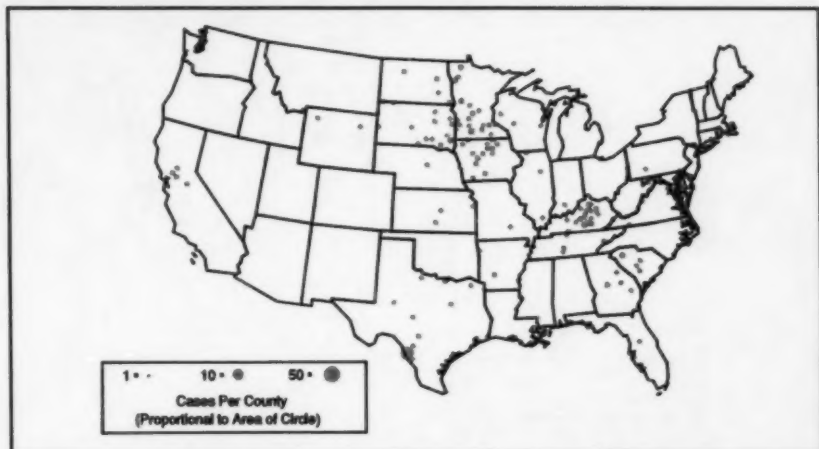
FIGURE 11. Reported cases of rabies in dogs, by county, 1987**FIGURE 12. Reported cases of rabies in cats, by county, 1987**

FIGURE 13. Reported cases of rabies in cattle, by county, 1987

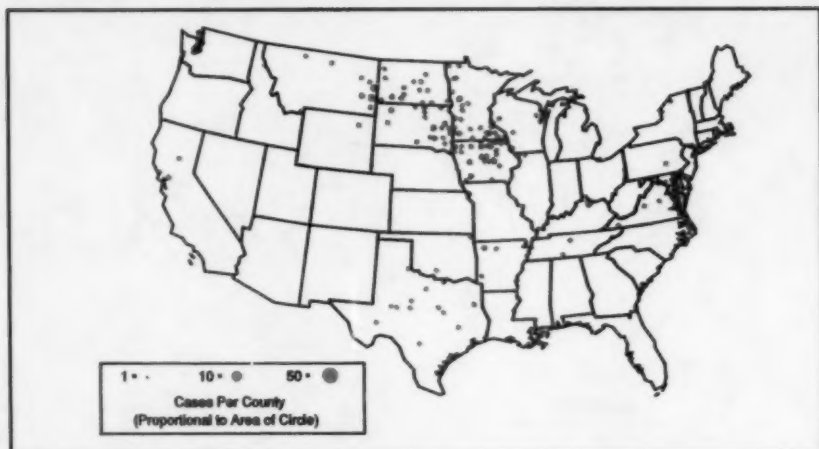


FIGURE 14. Reported cases of rabies, by month, United States, 1987

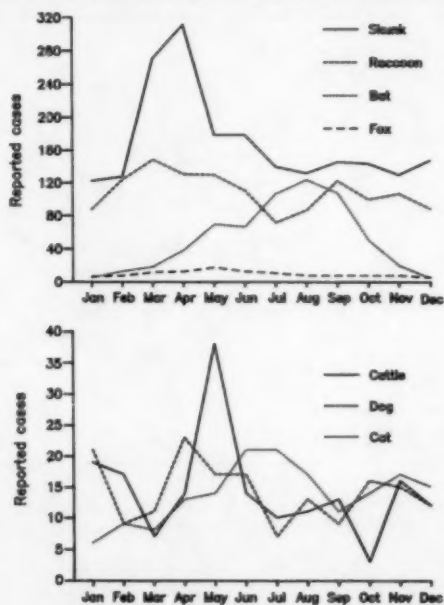
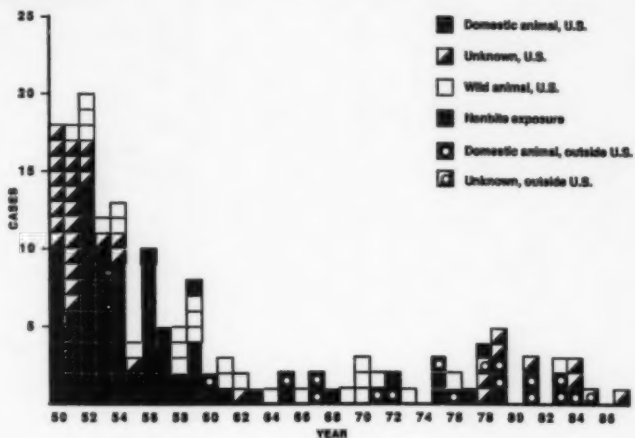


FIGURE 15. Rabies cases in humans and sources and location of exposure, United States, 1950-1987



State and Territorial Health Statistics Directors—May 1988

CDC gratefully acknowledges the assistance provided by State and Territorial Health Statistics Directors and their staffs.

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Kansas
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Louisiana
Maine
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Nebraska
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State and Territorial Epidemiologists and State Laboratory Directors are gratefully acknowledged for their contributions to this report. The persons listed below were in the positions shown as of July 1988.

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